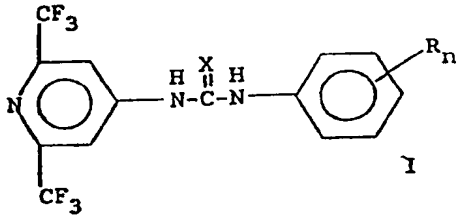
(12) UK Patent Application (19) GB (11) 2 068 365 A

(21) Application No 8003828
(22) Date of filing 5 Feb 1980
(43) Application published
12 Aug 1981
(51) INT CL³
C07D 213/58 A01N
43/40
(52) Domestic classification
C2C 1530 215 220 22Y
247 250 251 25Y 276 311
313 31Y 321 326 32Y 332
338 339 341 349 34Y 364
36Y 380 381 440 443 456
45Y 578 620 622 626 664
670 674 694 697 707
71X 724 72X 751 752
755 75X 76X 76Y 776
78Y 805 80Y AA KD MH
NG SM SU ZK
(56) Documents cited
None
(58) Field of search
C2C
(71) Applicant
Dow Chemical Company
Limited,
Meadowbank, Bath Road,
Hounslow, TW5 9QY
(72) Inventor
David Philip Clifford
(74) Agent
Boult, Wade & Tennant,
27 Furnival Street,
London, EC4A 1PQ

(54) Fungicidal Pyridyl Arylureas

(57) A compound having the formula



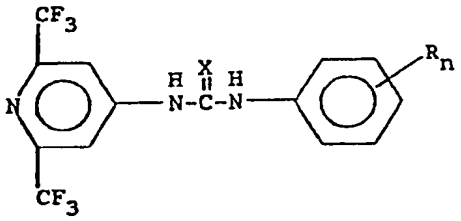
wherein R is halogen, trichloromethyl, trifluoromethyl nitro, cyano, C_1—C_4 alkyl or C_1—C_4 alkoxy; X is NH, O or S and n is an integer of from 1 to 5, which is useful as a fungicide on plants and other substrates susceptible to fungicidal attack.

GB 2 068 365 A

SPECIFICATION

Fungicidal Pyridyl Arylureas, Methods of Making Them, Formulations Containing Them and Method of Controlling Fungi and Bacteria

This invention relates to novel pyridyl arylureas having the formula



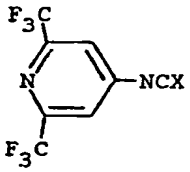
I

wherein R is halogen, trichloromethyl, trifluoromethyl, nitro, cyano, C_1—C_4 alkyl or C_1—C_4 alkoxy; X is NH, O or S and n is an integer of from 1 to 5, to fungicidal and bactericidal compositions containing such compounds, to methods for producing such compounds and to a method of controlling fungi and bateria with such compounds.

The novel products of the present invention are liquids or crystalline solid materials which are somewhat soluble in many common organic solvents and of very low solubility in water. They exhibit strong fungicidal and bactericidal properties.

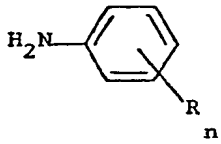
The preferred compounds are those having the formula I, in which R is $4CF_3$; $3,4\text{-}Cl_2$; $3\text{-}CF_3$, 4-Cl; $3,4,5\text{-}Cl_3$; $3\text{-}CF_3$; 4-Cl; or $4\text{-}OCH_3$; and X=O or S.

The present invention also provides a process for the preparation of pyridyl arylureas of the formula I in which a pyridinylisocyanate or isothiocyanate of the general formula



II

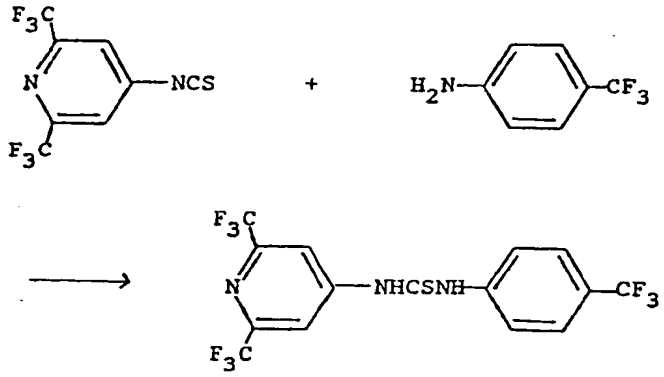
in which X=O or S, is reacted with an aniline of the general formula



III

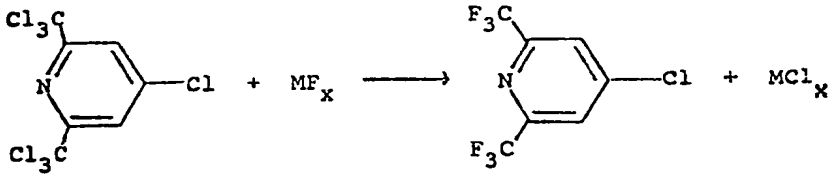
in which R and n have the above mentioned meanings, preferably in the presence of an inert diluent or solvent.

If 4-isothiocyanato-3,5-bis(trifluoromethyl)pyridine and 4-aminobenzotrifluoride are used as starting materials, the reaction can be represented by the equation



The compounds of the formula II have not been previously described in the literature. They can be prepared by the following course of reaction starting with the reaction of 2,6-lutidine and chlorine with the elimination of hydrogen chloride to yield 4-chloro-2,6-bis(trichloromethyl)pyridine, IV. The

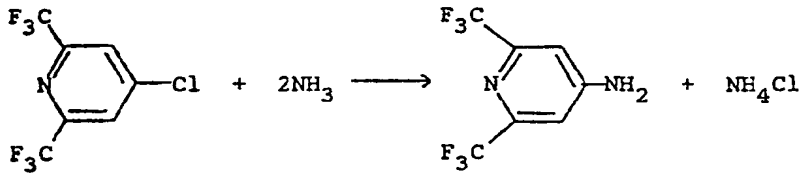
reaction is carried out in the vapour phase in the presence of a suitabl diluent especially carbon tetrachloride and an inert atmosphere preferentially nitrogen. The reaction temperature can be varied within a fairly wide range. In general, the reaction is carried out between 350° and 600°C preferably between 450° and 550°C. In carrying out the process according to the invention the amounts of the reactants are not critical, some of the desired product compound being obtained when employing the reactants in almost any amounts. However, the reaction consumes the reactants in proportions representing a molar ratio of 7:1 chlorine:2,6-lutidine and the use of amounts which represents such proportions is preferred. The resulting product, IV, may be fluorinated by treatment with an appropriate inorganic fluoride, V, to give the fluorinated material, VI, according to the following r action sequence



IV V VI

in which M=hydrogen and x=1 or M=antimony and x=3.

In carrying out the reaction according to the invention MF_x where M=antimony and x=3 was preferred. The presence of chlorine in essentially equimolar amounts served to catalyse the reaction. The reaction temperatures can be varied within a fairly wide range. In general, the reaction is carried out at between 80° and 130°C, preferably 95°—110°C. The amounts of reactants to be employed are not critical, some of the desired product being obtained when employing the reactants in almost any amounts. However, the reaction consumes the reactants in a molar ratio of 4-chloro-2,6-bis(trichloromethyl)pyridine, IV:antimony trifluoride: chlorine of 1:2:2 and the use of amounts which represent such proportions is preferred. Working up can be by conventional procedures but preferred is separation by steam distillation. 4-chloro-2,6-bis-trifluoromethylpyridine, VI, so formed may be aminated to give 4-amino-2,6-bis(trifluoromethyl)pyridine, VII, by aqueous or anhydrous ammonia the course of the reaction can be represented by the following equation:



VI VII

in which the aminated material, VII, is formed with elimination of hydrogen chloride which is conveniently scavenged by ammonia.

Thus, compounds of type II may be prepared by the treatment of 4-amino-2,6-bis(trifluoromethyl)pyridine, VII, with oxalyl chloride or thiophosgene the reaction being carried out preferably in the temperature range +50° and 150°C. The former results in the formation of the desired starting product of the formula II, where X=O, with the elimination of hydrogen chloride and carbon monoxide and the latter in the formation of II, wherein X=S, with the elimination of hydrogen chloride. The amines listed are compounds generally known to those skilled in the art and which can be prepared according to the methods which are generally known and customary in the laboratory.

Diluents which can be used for the reaction II with III are those organic solvents which are inert to isocyanates and isothiocyantes, especially dry hydrocarbons, for example, ligroin, petroleum either in the boiling range between 40° and 150°C, benzene, toluene, chloro and dichlorobenzenes, chlorinated hydrocarbons such as carbon tetrachloride, ketones such as acetone, acetonitrile and dimethylformamide.

The reaction temperature can be varied over a fairly wide range —20° and 100°C for isocyanates and 50° and 100°C for isothiocyanates.

The amounts of the reactants to be employed are not critical, some of the desired product compound being obtained when employing the reactants in any amounts. However, the reaction consumes the reactants in amounts representing equimolar proportions, and the use of amounts which represent such proportions is preferred.

In carrying out the reaction, the reactants can be contacted together in any convenient fashion and maintained for a period of time in the desired reaction temp rature rang . Following the completion of the reaction, the reaction mixture can be employed for useful purposes of the present

invention. However, the desired product compound can be separated from the reaction mixture by conventional procedures. Most typically, the reaction mixture is dried and filtered and the organic liquid employed as reaction mixture can be removed from the filtrate by evaporation under subatmospheric pressure. The product so obtained can be used without purification or can be purified by conventional procedures. For example, the separated product can be mixed with a quantity of any of the organic liquids to be employed as reaction medium, the resulting mixture filtered to separate insoluble by-product materials, and the organic liquid removed from the filtered mixture by evaporation under subatmospheric pressure, to obtain the purified product. Also, in the instance of those products which are solids the separated product can be purified by recrystallization.

Example 1

Preparation of 4-chloro-2,6-bis-trichloromethylpyridine

A gaseous mixture of 2,6-lutidine (2—3%), chlorine (30—40%) and nitrogen and carbon tetrachloride as a dilutent (ca. 60%) were passed through a tubular reactor (12"x1") at 450°—550°C in 2 seconds. The vapours were cooled and the title compound isolated in good yield, m.p. 101°—102°C.

Example 2

Preparation of 4-chloro-2,6-bis(trifluoromethyl)pyridine

To a stirred mixture of 4-chloro-2,6-bis-trichloromethylpyridine (104.5 g, 0.3 mole) and anhydrous antimony trifluoride (126.3 g, 0.7 mole) was introduced an atmosphere of chlorine. The ensuing exotherm was controlled by adjusting the rate of influx of chlorine gas and a temperature of 100°—110°C maintained. On completion of the reaction, the temperature was allowed to fall to 50°C and the mixture added to ice cold hydrochloric acid (650 ml, 8%). The mixture was steam distilled and the filtrate extracted with methylene chloride. The solvent was removed under reduced pressure from the dried solution ($MgSO_4$) to give 52.7 g, 70%, m.p. 57°—60°C.

Example 3

Preparation of 4-amino-2,6-bis(trifluoromethyl)pyridine

a) 4-chloro-2,6-bis(trifluoromethyl)pyridine (50 g, 0.20 mole) in ammonia (250 ml, d 0.88) and ethanol (250 ml) containing copper sulphate (ca. 0.5 g) was stirred and heated in a pressure vessel at 100°—120°C for 5 hours. The mixture was cooled and extracted with methylene chloride. The solvent was removed under reduced pressure from the dried solution ($MgSO_4$) leaving a cream solid (26 g, 56%) m.p. 147°—149°C.

b) 4-chloro-2,6-bis(trifluoromethyl)pyridine (51 g) and anhydrous ammonia (124 ml) were heated in a pressure vessel at 100°C for 2 hours. The ammonia was evaporated and the pale yellow solid extracted with acetone, concentrated, and added to ice water. The solid thus formed was filtered, dried *in vacuo* at 65°C to give 41.5 g, 90%, m.p. 146.5°—147°C.

Crystallisation from carbon tetrachloride gave a colourless solid, m.p. 146.5—147°C.

$C_7H_4F_6N_2$:	Found,	36.48; H, 1.87; N, 12.15
	Req.,	C, 36.52; H, 1.74; N, 12.17%.

Example 4

Preparation of 4-isocyanato-2,6-bis(trifluoromethyl)pyridine

To a stirred and refluxing solution of oxalyl chloride (64 g, 0.5 mole) in dry benzene (100 ml) was added a slurry of 4-amino-2,6-bis(trifluoromethyl)pyridine (20 g, 0.087 mole) in warm benzene (150 ml) over 1 hour. The mixture was then heated under gentle reflux for 5 hours, cooled and filtered. The solvent and excess oxalyl chloride were removed from the filtrate and the oil taken up in dry dichlorobenzene (100 ml) and heated under gentle reflux for 12 hours. The solvent was removed at 90°C/20 mmHg leaving the isocyanate in good yield.

Example 5

Preparation of 4-isothiocyanato-2,6-bis(trifluoromethyl)pyridine

4-amino-2,6-bis(trifluoromethyl)pyridine (10 g, 0.043 mole) and thiophosgene (21.9 g, 0.18 mole) in dry benzene (250 ml) containing triethylamine (6 drops) were heated under reflux for 5 hours. The solvents and excess thiophosgene were removed under reduced pressure to give an almost quantitative yield of the isothiocyanate as a pale brown solid.

Example 6

Preparation of N-(2,6-bis(trifluoromethyl)-4-pyridinyl)-N'-3,4-dichlorophenylurea

4-isocyanato-2,6-bis(trifluoromethyl)pyridine (1.28 g, 0.005 mole) (Example 4) in dry benzen (10 ml) was treated with 3,4-dichloroaniline (0.81 g, 0.005 mole) in dry benzene (10 ml). The mixture was allowed to stand at ambient temperature for 2 hours and then filtered 1.4 g, m.p. 207°—209°C. Crystallisation from benzene gave a colourless solid, m.p. 211.5°—212.5°C.

$C_{14}H_7Cl_2F_6N_3O$: Found, C, 39.97; H, 1.94; N, 9.96
Req., C, 40.19; H, 1.67; N, 10.05%.

Example 7

Preparation of N-(2,6-bis(trifluoromethyl)-4-pyridinyl)-N'-(4-trifluoromethylphenyl)thiourea

A mixture of 4-aminobenzotrifluoride (1.48 g) and 4-isothiocyanato-2,6-bis(trifluoromethyl)pyridine (2.5 g, 0.01 mole) in dry benzene (25 ml) containing several drops of triethylamine was heated under reflux for 7 hours. Removal of the solvent and triethylamine gave a colourless solid 2.9 g, m.p. 125°—132°C. Crystallisation from benzene furnished a sample, m.p. 132°C.

$C_{15}H_8F_9N_3S$: Found, C, 41.46; H, 2.00; N, 9.97; F, 39.25
Req., C, 41.57; H, 1.85; N, 9.70; F, 39.49%.

The following compounds were obtained by methods analogous to those employed in Examples 6 and 7.

Table I

Compound	R	X	% Yield	Solvent of Crystallisation/ Crystal Form	m.p. °C	Elemental Analysis % Req./Found C	H	N
1	2-CH_3	O	43	Benzene	260	49.59	3.03	11.57
						49.45	3.45	11.13
2	2-Cl	S	30	Pet. ether 60—80	152	42.05	2.00	10.51
						42.34	2.30	10.22
3	2-Cl	O	51	Benzene col. needles	204	43.81	2.09	10.95
						43.83	1.99	10.93
4	2-CF_3	S	42	Pet. ether 60—80 col. needles	161	41.57	1.85	9.70
						41.81	2.00	10.00
5	2-CF_3	O	45	Benzene	211	43.16	1.91	10.07
						42.90	2.00	10.14
6	3-CH_3	O	29	Benzene fawn needles	204	49.59	3.03	11.57
						50.08	3.42	11.56
7	3-OCH_3	O	18	Benzene fawn needles	192	47.49	2.90	11.08
						47.34	2.99	11.00
8	3-CN	O	42	Washed residue pale yellow needles	277	48.18	2.14	14.97
						48.36	2.18	15.07
9	3-Cl	O	47	Benzene col. needles	205	43.81	2.09	10.95
						44.14	2.34	10.66
10	3-F	O	64	Benzene fawn needles	203	45.78	2.18	11.44
						45.73	2.58	11.75
11	3-CF_3	O	46	Benzene	184	43.16	1.91	10.07
						43.16	2.31	10.27
12	4-CH_3	O	22	Benzene col. needles	241	49.59	3.03	11.57
						50.36	3.20	11.46
13	4-OCH_3	S	10	Benzene/Pet. ether	165	45.57	2.78	10.63
						45.36	3.02	10.75
14	4-OCH_3	O	56	Benzene col. needles	202	47.49	2.90	11.08
						47.19	3.25	10.99
15	4-CN	O	78	Ethyl acetate	>300	48.13	2.14	14.97
						47.82	2.35	15.19
16	4-NO_2	O	35	Ethyl acetate/ benzene	>300	42.64	2.09	10.95
						42.53	1.99	10.93
17	4-Cl	S	42	Benzene/Pet. ether	125	42.05	2.00	10.51
						42.21	2.05	10.91
18	4-Cl	O	45	Benzene col. needles	204	43.81	2.09	10.95
						44.43	2.29	10.76
19	4-CF_3	S	67	Benzene	132	41.57	1.85	9.70
						41.46	2.00	9.97
20	4-CF_3	O	76	Benzene col. prisms	199	43.17	1.92	10.07
						42.91	2.08	10.14
21	2,3-Cl_2	O	64	Benzene fawn needles	212	40.19	1.67	10.05
						40.54	1.79	9.60

Table I (Continued)

Compound	R	X	% Yield	Solvent of Crystallisation/ Crystal Form	m.p. °C	Elemental Analysis % Req./Found C	H	N
22	2,4-Cl_2	O	51	Benzene col. needles	199	40.19 40.75	1.67 1.58	10.05 9.68
23	2,5-Cl_2	O	57	Benzene col. needles	199	40.19 40.56	1.67 1.72	10.05 9.84
24	2,6-Cl_2	O	33	Benzene col. needles	230	40.19 40.36	1.67 1.86	10.05 10.23
25	3,4-Cl_2	O	67	Benzene col. flakes	212	40.19 39.97	1.67 1.94	10.05 9.96
26	2,4,5-Cl_3	O	30	Benzene col. needles	223	37.13 37.46	1.33 1.31	9.28 9.54
27	2,4,6-Cl_3	O	38	Benzene col. needles	243	37.13 37.26	1.33 1.18	9.28 9.41
28	3,4,5-Cl_3	O	69	Benzene col. needles	239			9.28 8.82
29	Cl_5	O	26	Benzene col. needles	295	32.21 32.44	0.77 0.68	8.05 8.04
30	4-Cl, 3-CF_3	O	64	Benzene col. needles	177			9.30 8.85
31	4-SCN, 3-Cl	O	69	Benzene/ethanol fawn needles	217			12.71 12.12
32	3,5$(CF_3)_2$	O	20	Benzene col. needles	192			8.59 8.70

The active compounds according to the invention exhibit a strong fungitoxic acition. Their low toxicity to mammals and their good tolerance by higher plants is advantageous in their use as plant protection agents. Compositions containing these compounds may be applied to growing vegetation in amounts required for effective control without significant injury to the plants.

It has been found that the present compounds are particularly adapted to be employed for the control of a wide range of bacteria and fungi from the most diverse classes such as Oomycetes, Ascomycetes, Basidiomycetes and Fungi Imperfecti. The active compounds according to the invention, can be used against parasitic fungi on above ground parts of plants, fungi which attack the plant through the soil, seed-borne fungi and fungi which inhabit the soil. They are particularly active against ascomycetes, Oomycetes and Fungi Imperfecti. The following may be mentioned as important fungi to be combated with the above active compounds according to the invention: *Plasmopara viticola, Erysiphe graminis, Podosphaera leucotricha* and *Phytophthara parasitica* var *nicotinae.*

In further operations, the compounds can be included in inks, adhesives, soaps, cutting oils, polymeric materials, or in oil or latex paints, to provent mold, mildew, and the degradation of such products resulting from microbial attack. Also the compounds can be distributed in textile or cellulosic materials, or can be employed in the impregnation of wood and lumber to preserve and protect such products from the attack of the microbial agents of rot, mold, mildew and decay. The foregoing environments are merely illustrative of the many habitats in which these agents can be distributed to obtain excellent fungal control.

The method of the present invention comprises contacting a fungal organism with a fungicidal amount of one or more of the compounds. However, the present invention also embraces the employment of a liquid, powder or dust composition containing one or more of the compounds and one or more additives including organic solvents, petroleum distillates, water or other liquid carriers, surface active dispersing agents, and finely divided inert solids. In such compositions, the compounds oftentimes are present in a concentration from 2 to 98 percent by weight or when the carrier is a surface active agent, from 0.1 to 20 percent by weight. Depending upon the concentration in the composition of the compound, such augmented compositions are adapted to be employed for the control of the undesirable fungi or employed as concentrates and subsequently diluted with additional inert carrier to produce the ultimate treating compositions. In general, however, good results can be obtained with liquid compositions containing from 0.0001 to 2.0 percent by weight of the toxicant. With dusts, good results can usually be obtained with compositions containing from 0.0001 to 2.0 percent or more by weight of toxicant. Where the compositions ar to be applied to living plants, it is pref rred that the toxicant be present in an amount not to exc ed 0.8 perc nt in liquid compositions and 1.0 percent in dusts. In terms of acreage application, good controls of fungal organisms can be obtained when the compounds are applied to plots of growing plants at a dosage of from 0.004 to 3 or more pounds per acre (0.0045 to 3.36 kg/hectare).

In the protection and preservation of inks, adhesives, cutting oils, paints, textiles and paper, good results can be obtained when the compounds are incorporated in such products in the amount of at least 0.0001 percent by weight. In the preservation of wood, excellent results can be obtained when the compounds are incorporated by conventional treatment in the wood in the amount of at least 0.0001 pound per cubic foot (0.0016 kg/cu. m) of wood.

The fungicidal and bactericidal activity of the compounds of the present invention are illustrated by the following examples where solutions or suspensions of the test chemical were prepared, at the desired concentration, in aqueous acetone or isopropanol containing a small amount of a suitable wetter.

Example 8

Grape Downy Mildew Protectant Test

The underside of the leaves of grape seedlings (cv. Carignane) at the 3—4 leaf stage were sprayed with an aqueous suspension of the test material. After application, the underside of the plant leaves were sprayed with a spore suspension of *Plasmopara viticola* in distilled water and stored in an infection chamber at 20° to 22°C and 100% r.h. for 7—8 days. When the disease symptoms were well developed, the seedlings were graded for disease control by rating untreated seedlings as 'no control' and those with the absence of disease symptoms as '100% control'.

The active compounds, their concentration of use and the results can be seen from the following table.

Table II

Grape Downy Mildew/Protectant

Active Compound Number	*Control in % Over an Active Compound Concentration Range of*			
	0.04%	*0.01%*	*0.0025%*	*0.00062%*
2	100	70	35	—
3	100	100	70	—
4	100	75	25	—
6	75	—	—	—
7	85	75	35	—
8	83	—	—	—
9	85	45	5	—
10	90	50	30	—
11	100	90	55	—
12	100	85	75	—
13	—	100	—	—
14	100	40	5	—
15	80	45	25	—
16	100	30	0	—
17	100	70	25	—
18	100	100	40	—
19	—	99	—	—
20	95	90	90	—
21	50	—	—	—
22	100	100	0	—
23	50	—	—	—
25	—	—	99	50
26	40	—	—	—
28	—	100	100	67
29	75	—	—	—
30	100	100	93	50
32	—	25	—	—

Example 9

C real Powdery Mildew Protectant Test

Barley plants (cv. Berac) at the 1—2 leaf stage were sprayed with an aqueous suspension of the test chemical by a moving nozzle sprayer until just completely wet. The plants were allowed to stand and dry (3—4 hours) and then inoculated by dry dusting with conidia of *Erysiphe graminis* before being placed in a greenhouse at 20°—25°C with a minimum day length of 12 hours. Assessment was made 7—8 days later, where untreat d plants were rated as 'no control' and thos with th absence of disease syptoms as '100% control'.

The active compounds, their concentration of use and the results can be seen from the following table.

Table III
Cereal Powd ry Mildew/Protectant

Active Compound Number	*Control in % Over an Active Compound Concentration Range of*		
	0.04%	*0.01%*	*0.0025%*
1	65	56	42
3	47	28	26
7	58	40	14
8	54	42	19
9	46	28	23
12	44	37	33
14	49	42	38
15	44	33	26
16	54	35	12
20	44	37	30
21	47	44	29
22	53	47	29
23	60	47	20
24	53	53	29
25	44	36	24
26	49	33	16
27	53	42	20
29	67	53	31

Example 10
Apple Powdery Mildew Protectant Test

Apple seedlings (cv. Red Delicious) at the 4—6 leaf stage were sprayed to run off with a solution or suspension of the test chemical. The plants were held in a greenhouse for 48 hours at 20°—22°C and then inoculated with an aqueous suspension of freshly harvested conidia of *Podosphaera leucotricha* (10^6 propagules/ml). The plants were graded after 7—12 days when inoculated, but untreated, plants sporulated profusely. The assessments were expressed as a percent control where inoculated, but untreated plants were rated as 'no control' and the absence of disease symptoms as '100% control'.

The active compounds, their concentrations of use and the results can be seen from the following table.

Table IV
Apple Powdery Mildew/protectant

Active Compound Number	*Control in % at an Active Compound Concentration of 0.04%*
19	50
25	90
28	95
30	100
32	90

Example 11
Tobacco Black Shank Root Drench Test

Tobacco seedlings (cv. Coker) at the third leaf stage were transplanted into soil heavily infested with *Phytophthora parasitica* var *nicotinae.* The soil was drenched with the toxicant solution on suspension (30 ml) at the appropriate concentration and the plants then incubated above soil beds heated to 29°C to enhance disease development. The test was graded on the basis of transplant survival and expressed as a percent: 0% means no plants survived; 100% means that the test was quivalent to an uninoculated control.

The active compounds, their concentrations of use and the results can be seen from the following table.

Table V
Tobacco Black Shank/Root Drench

Active Compound Number	*Control in % at an Active Compound Concentration of 0.0025%*
10	100
11	100
14	100
17	100

Example 12
Anti-fungal and Anti-bacterial *'in vitro'* Tests

The test compounds were applied as solutions or suspensions in isopropanol to warm melted agar to achieve the desired concentration and then poured into petri dishes and allowed to solidify. Droplets of the appropriate test organism were applied to the surface of the agar with an 'Accu Drop'. The plates were incubated at the appropriate temperature and time for the organism. The tests were assessed for inhibition of 50% of the organism and the IC_{50} recorded as the lowest concentration at which this was achieved. The active compounds and the results can be seen from the following table.

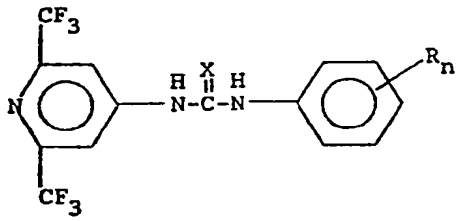
Table VI

Active Compound Number	*Control Expressed as an IC_{50} µg/ml on the Following Organisms*						
	S.m.	*S.a.*	*T.m.*	*B.s.*	*C.p.*	*P.p.*	*R.n.*
18		1.0	1.0	10.0	10.0	10.0	10.0
19	0.06	0.5	5.0	1.0	50.0	10.0	
25		1.0	1.0	1.0		1.0	1.0
28		1.0	1.0	1.0		1.0	1.0
30		1.0	1.0	1.0		1.0	1.0
31		1.0		1.0		10.0	

S.m., *Streptococcus mutans;*
S.a., *Staphylococcus aureus;*
T.m., *Tricophton mentagrophytes;*
B.s., *Bacillus subtilis;*
C.p., *Candida pelliculosa;*
P.p., *Pullularia pullulans;*
R.n., *Rhizopus nigricans.*

Claims

1. A compound having the formula



I

wherein R is halogen, trichloromethyl, trifluoromethyl, nitro, cyano, C_1—C_4 alkyl or C_1—C_4 alkoxy; X is NH, O or S and n is an integer of from 1 to 5.

2. Compound of Claim 1 wherein X is O or S, R is 4-CF_3; 3,4-Cl_2; 3-CF_3, 4-Cl; 3,4,5-Cl_3; 3-CF_3; 4-Cl; or 4-OCH_3.

3. N-(2,6-bis(trifluoromethyl)-4-pyridinyl)-N'-(3,4-dichlorophenyl)thiourea.

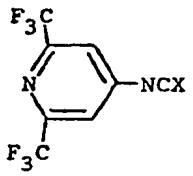
4. N-(2,6-bis(trifluoromethyl)-4-pyridinyl)-N'-(4-methoxyphenyl)thiourea.

5. N-(2,6-bis(trifluoromethyl)-4-pyridinyl)-N'-(4-chlorophenyl)thiourea.

6. N-(2,6-bis(trifluoromethyl)-4-pyridinyl)-N'-(4-trifluoromethylphenyl)thiourea.

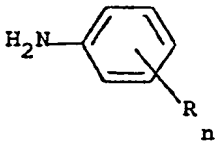
7. Any one of Compounds 1 to 32 in Table 1 herein.

8. A process for preparing a compound as claimed in Claim 1, which process comprises reacting a pyridinylisocyanate or isothiocyanate having the formula



II

wherein X is oxygen or sulfur with an aniline of the general formula



III

wherein R and n are as defined in Claim 1.

9. A process as claimed in Claim 8 wherein the compound of Formula II have been prepared substantially as hereinbefore described.

10. A process as claimed in Claim 8 substantially as hereinbefore described in Example 6 or Example 7, or any of the individual Runs of Table 1.

11. A compound as claimed in Claim 1 which has been prepared by a process as claimed in any one of Claims 8 to 10.

12. A fungicidal or bactericidal formulation comprising one or more of the compounds claimed in any one of Claims 1 to 7 and 11 formulated for fungicidal or bactericidal use, optionally together with a fungicidally or bactericidally acceptable diluent, carrier or excipient.

13. A formulation as claimed in Claim 12 which is in the form of a liquid, a powder or a dust.

14. A liquid formulation as claimed in Claim 13 containing 0.0001 to 2.0 percent by weight of the compound(s).

15. A liquid formulation as claimed in Claim 14 containing up to 0.8 percent by weight of the compound(s).

16. A dust formulation as claimed in Claim 13 containing 0.0001 to 2.0 percent by weight of the compound(s).

17. A dust formulation as claimed in Claim 16 containing up to 1.0 percent by weight of the compound(s).

18. A formulation as claimed in Claim 12 comprising a carrier which is a surface active agent.

19. A formulation as claimed in Claim 18 containing 0.1 to 20 percent by weight of the compound(s).

20. A formulation as claimed in Claim 12 substantially as hereinbefore described in any one of Examples 8 to 12.

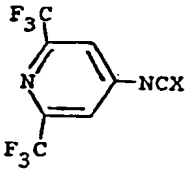
21. A method of controlling fungal or bacterial organisms, which method comprises contacting the organisms with a fungicidally or bactericidally effective amount of one or more compounds claimed in any one of Claims 1 to 7 and 11.

22. A method as claimed in Claim 22 wherein the compound(s) are in the form of a formulation as claimed in any one of Claims 12 to 20.

23. Ink, adhesive, soap, cutting oil, polymeric material, oil paint or latex paint containing one or more compounds as claimed in any one of Claims 1 to 7 and 11 in sufficient amount to prevent mold, mildew, and the degradation of such products resulting from microbial attack.

24. Textile material, cellulosic material, wood or lumber containing one or more compounds as claimed in any one of Claims 1 to 7 and 11 in sufficient amount to preserve and protect such products from the attack of the microbial agents of rod, mold mildew and decay.

25. A compound having the formula



II

wherein X is oxyg n or sulfur.

26. A process for preparing a compound as claimed in Claim 25, which process comprises reacting 4-amino-2,6-bis(trifluoromethyl)pyridine with oxalyl chloride or thiophosgene.

27. A process as claimed in Claim 26 wherein the reaction is carried out at a temperature within the range 50°C to 150°C.

28. A process as claimed in Claim 26 or Claim 27, wherein the 4-amino-2,6-bis(trifluoromethyl)pyridine has been prepared by aminating 4-chloro-2,6-bis(trifluoromethyl)pyridine.

29. A process as claimed in Claim 28, wherein the 4-chloro-3,5-bis(trifluoromethyl)pyridine has been prepared by fluorinating 4-chloro-2,6-bis(trichloromethyl)pyridine.

30. A process as claimed in Claim 29, wherein fluorination is effected using HF or SbF_3.

31. A process as claimed in Claim 29 or Claim 30, wherein the reaction is carried out in the presence of chlorine in an amount sufficient to catalyse the reaction.

32. A process as claimed in Claim 29, wherein the 4-chloro-3,5-bis(trifluoromethyl)pyridine has been prepared by reacting 4-chloro-2,6-bis(trichloromethyl)pyridine with antimony trifluoride in the presence of a catalytic amount of chlorine, the molar ratio of 4-chloro-2,6-bis(trichloromethyl)pyridine:antimony trifluoride:chloride being about 1:2:2.

33. A process as claimed in any one of Claims 29 to 32, wherein the reaction is carried out at a temperature within the range of 95°C to 110°C.

34. A process as claimed in any one of Claims 29 to 33, wherein the 4-chloro-2,6-bis(trichloromethyl)pyridine has been prepared by reacting 2,6-lutidine with chlorine in the vapour phase in the presence of a suitable diluent.

35. A process as claimed in Claim 34, wherein the molar ratio of chlorine:2,6-lutidine is 7:1.

36. A process as claimed in Claim 34 or Claim 35, wherein the reaction is carried out at a temperature of from 450°C to 550°C.

37. A process as claimed in Claim 29, wherein the 4-chloro-2,6-bis(trichloromethyl)pyridine has been prepared substantially as hereinbefore described in Example 1.

38. A process as claimed in Claim 28, wherein the 4-chloro-2,6-bis(trifluoromethyl)pyridine has been prepared substantially as hereinbefore described in Example 2.

39. A process as claimed in Claim 26, wherein the 4-amino-2,6-bis(trifluoromethyl)-pyridine has been prepared substantially as hereinbefore described in Example 3.

40. A process as claimed in Claim 26 substantially as hereinbefore described in Example 4 or Example 5.

41. A compound as claimed in Claim 25 which has been prepared by a process as claimed in any one of Claims 26 to 40.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1981. Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.